REMARKS/ARGUMENTS

Current claims 16-31 are cancelled without prejudice or disclaimer. New claims 32- 57 have been added. New independent claim 32 is based on claim 16 as filed and on description as filed page 4 l.10-14, page 5 l.35-page 6 l.3, page 8 l.1-8 and l.18-19, page 9 l.17-21, page 12 l.13-30. New independent claim 37 is based on claim 23 as filed and on description as filed page 8 l.9-19 and l.25-27, page 9 l.17-21, page 12 l.13-30. Claims 42-57 are based on claims 16-31 as filed. Therefore, no unsearched subject matter has been added to the amended set of claims.

Claim Rejections – 35 USC §102 and 35 USC §103

All new independent claims 32, 37, 42 and 57 contain difference with the prior art. The problem to be solved by the method and apparatus according to the invention is to provide a maximum accuracy when providing flow rates of a multiphase fluid flowing in a well, especially when the well is deviated or horizontal. In such conditions, the different phases of the fluid tend to segregate. This segregation can lead to regions in which there is a very high gas content, and other regions in which there is a very high liquid (oil and/or gas) content, the flow behavior in each region can be very different. Therefore it is very important to perform both speed measurement and proportion measurement in at least two different regions of the well to be able to accommodate such differences and provide flow measurements indicative of the whole well.

Therefore, the method and apparatus according to the invention provides pairs of local speed and proportion measurements. Thanks to this feature, the method of this invention enables to measure in a first region of the well a first pair of local speed of the flowing fluid in a first location of the well; and local proportions of the flowing fluid in a second location of the well, such that said first and second locations are in alignment with each other on a line parallel to the axis of the well; the method further including the step of measuring simultaneously in a second region of the well a second pair of said local speed and said local proportions, wherein the first and the second regions are in the same plane containing the axis of the well.

Therefore, for each pair, the speed and proportion data are acquired in the same type of flow by performing the measurements in two locations that are in alignment with each other on a line parallel to the axis of the well (i.e. the speed and proportion sensor means lie in the same flow regime). Consequently, if the well is deviated or horizontal and the different phases segregate horizontally, these measurements are going to be performed in the same horizontal layer. The pairs of local speed and proportion measurements are made in different regions lying in the plane containing the axis of the well, but separated from each other. For example, a first pair of local speed and proportion measurements might relate to a flow regime that is predominantly gas, whereas a second pair of local speed and proportion measurements might relate to a flow that is predominantly oil. Consequently, the flow rates of each flow regime can be deduced with much more accuracy than with any other prior art method.

Examiner concluded that the set of claims lack novelty in view of document US 5,574,263. Applicant respectfully shat this conclusion is not supported by any evidence. Document US 5,574,263 discloses a production logging tool for use in deviated wellbore, wherein the fluid parameters are measured at different selected points across the borehole. Nevertheless, it is nowhere mentioned in this document that is essential to make composition and velocity measurement by pairs using an apparatus for determining flow rates in a multiphase fluid flowing in a well, comprising: a tool body to be positioned in the well; a first and a second sensor pairs, each sensor pair comprising - speed sensor mounted on the tool body for measuring local speed of the flowing fluid in a first location of the well; and proportion sensor mounted on the tool body for measuring local proportions of the fluid flowing in a second location of the well- wherein said speed and proportion sensors are arranged such that said first and second locations are in alignment with each other on a line parallel to the axis of the well; and wherein said first and second sensor pairs lie in the same plane containing the axis of the well.

Document US 5,574,263 refers to the existence of a single spinner for determining the effluent velocity, said spinner being located in the middle of the effluent flow (see col.6, l.64-67; col.7, l.4-10 and l.28-30; col.10, l.15-17 and l.53-56). The only paragraph where this document mentions the possibility of having more than one flow meter is at col. 11, l.13-17. However, even in this case, there is no mention that, when a plurality of velocity sensors is provided, combining

velocity data and composition data is of critical importance. Actually, there is nothing in the cited prior art that enables a man skilled in the art to come to the point of the claimed apparatus and methods. This document does not enables a man skilled in the art to use pair of velocity/composition data in order to have a precise idea of each of the flow profiles that exist in the well when, due to deviation, the various phases of the effluent segregate.

The Applicants believe that these amendments deal with all outstanding matters, raise no new matter issues and place the application in order for allowance. Favorable reconsideration on the basis of these amendments and remarks is requested. In the event that the Examiner intends to maintain any rejection, it is requested that these amendments be entered in order to place the application in better state for appeal.

Please charge any additional fees made necessary by this amendment to Schlumberger Deposit Account No. 50-2183.

Respectfully submitted

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VERSION WITH MARKING TO SHOW CHANGES MADE

In the Claims

Claims 16-31 are cancelled without prejudice or disclaimer.

New claims 32-57 have been added:

32. (New) A method of determining flow rates in a multiphase fluid flowing in a well, comprising measuring in a first region of the well a first pair of:

(i) the local speed of the flowing fluid in a first location of the well; and

(iii) the local proportions of the flowing fluid in a second location of the well, such that said first and second locations are in alignment with each other on a line parallel to the axis of the well;

characterised in that the method further comprises measuring simultaneously in a second region of the well a second pair of said local speed and said local proportions, wherein the first and the second regions are in the same plane containing the axis of the well.

33. (new) A method as claimed in claim 32, wherein said first and second regions are distributed across the entire width of the well.

34. (New) A method according to claim 32, wherein said plane containing the axis of the well is vertical.

35. (New) A method as claimed in claim 32, wherein the well is inclined from vertical, the method comprising measuring a first pair of local speed and local proportions of the flowing fluid in a first region lying at the bottom of the vertical plane of the well, and measuring second pairs of local speed and local proportions of the flowing fluid in second regions distributed across the entire width of the well in the vertical plane.

36. (New) A method as claimed in claim 32, wherein said first and second locations are at the same point in each first and second regions.

37. (New) Apparatus for determining flow rates in a multiphase fluid flowing in a well, comprising:

- a tool body to be positioned in the well;
- a first pair of:
  a) speed sensor means mounted on the tool body for measuring local speed of the flowing fluid in a first location of the well; and
  b) proportions sensor means mounted on the tool body for measuring local proportions of the fluid flowing in a second location of the well;
  wherein said speed and proportions sensor means are arranged such that said first and second locations are in alignment with each other on a line parallel to the axis of the well;

characterised in that said apparatus further comprises at least a second pair of said speed and proportions sensor means such that said first and second pairs lie in the same plane containing the axis of the well.

38. (New) Apparatus as claimed in claim 37, wherein, in use, said pairs of speed and proportions sensor means are distributed across the entire width of the well.

39. (New) Apparatus as claimed in claim 38, wherein when the well is inclined from vertical, said plane containing the axis of the well is vertical and the first pair of speed and proportions sensor means lies at the bottom of said vertical plane.

40. (New) Apparatus as claimed in claim 39, further comprising a pair of speed and proportions sensor means lying at the top of the vertical plane of the well

41. (New) Apparatus as claimed in claim 37, wherein each pair of the speed sensor means (26) and the proportions sensor means (28) are included in multi-sensor assemblies (24).

42. (New) A method of determining flow rates in a multiphase fluid flowing in a well, comprising:

(i) measuring local speed of the flowing fluid in a region of the well; and

(ii) measuring local proportions of the fluid flowing in a region of the well;

wherein the region in which the local speed is measured and the region in which the local properties are measured lie in a vertical plane of the well;

(iii) measuring both local speed and local proportions of the phases in at least two regions that lie in a vertical plane of the well which includes the longitudinal axis of the well and are offset from each other parallel to the axis of the well.

43. (New) A method as claimed in claim 42, comprising measuring local speed and local proportions of phases at regions distributed across the entire width of the well.

44. (New) A method as claimed in claim 42, wherein the well is inclined from vertical, the method comprising measuring local speed and local proportions of phases at a region lying at the bottom of the vertical plane of the well, and measuring local speed and local proportions of phases at other regions distributed across the entire width of the well in the vertical plane.

45. (New) A method as claimed in claim 44, further comprising measuring local speed and local proportions of phases at a region lying at the bottom of the vertical plane of the well

46. (New) A method as claimed in claim 42, in which a section element (Δsi) of the well is assigned to each region, and the overall flow rate Q of each phase is determined from the relationship:

$$Q = \sum_i q_i \cdot \frac{\Delta si}{S}$$

where S is the total vertical section of the well

and q_i is the flow rate of each phase in section element Δsi,

with $q_i = v_i . h_i$

where v_i is the local speed of each phase in section element Δsi

and h_i is the local proportion of each phase in section element Δsi.

47. **(New)** A method as claimed in claim 42, comprising measuring the local speed and local proportions of the phases at the same point in each region.

48. **(New)** A method as claimed in claim 42, comprising, in each region, measuring local speed and local proportions of phases in different locations that are aligned with each other parallel to the longitudinal axis of the well.

49. **(New)** Apparatus for determining flow rates in a multiphase fluid flowing in a well, comprising:

(i) a tool body to be positioned in the well;

(ii) speed sensor mounted on the tool body for measuring local speed of the flowing fluid in a region of the well; and

(iii) proportion sensor mounted on the tool body for measuring local proportions of the fluid flowing in a region of the well;

wherein:

- the region in which the local speed is measured and the region in which the local properties are measured lie in a vertical plane of the well; and

- said local speed and proportion sensors are provided for measuring both local speed and local proportions of the phases in at least two regions that lie in a vertical plane of the well which includes the longitudinal axis of the well and are offset from each other parallel to the axis of the well.

50. **(New)** Apparatus as claimed in claim 49, wherein, in use, the local speed and proportion sensors lie at regions distributed across the entire width of the well.

51. **(New)** Apparatus as claimed in claim 49, wherein when the well is inclined from vertical, local speed and proportion sensors are provided at a region lying at the bottom of the vertical plane of the well and for measuring local speed and local